Numerical Simulation of Particle and Energy Fluxes to Material Surfaces in Tokamak

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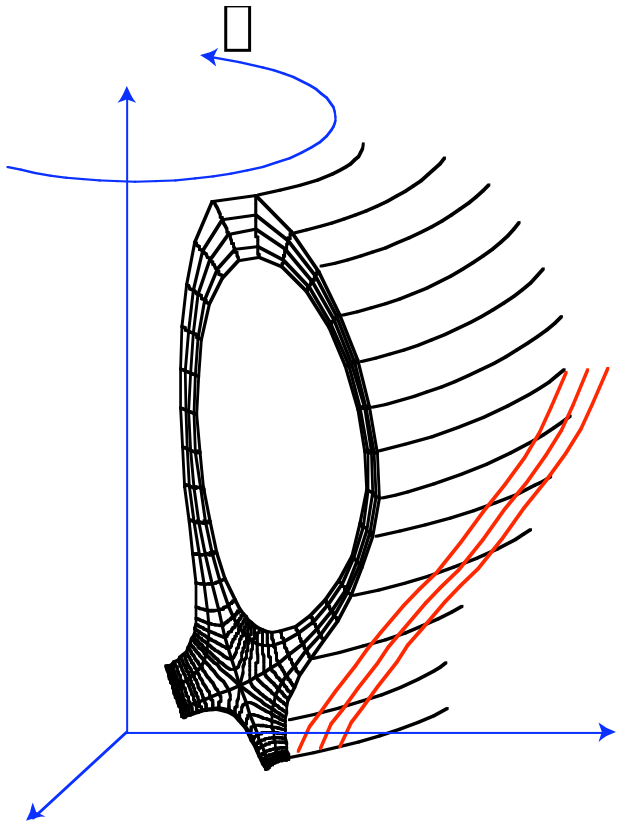
Our motivation is developing a physics-based model of plasma fluxes

- **Plasma turbulence can drive large radial fluxes of particles and energy**
- **Understanding edge-plasma turbulence is critical for predicting PFC lifetime**
- **Numerical simulation of edge-plasma turbulence gives quantitative assessment of such fluxes**

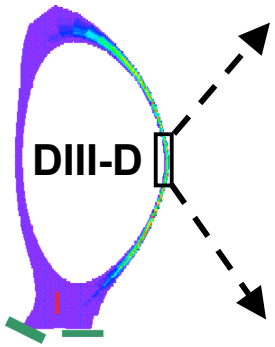
BOUT is a numerical tool for direct simulation of edge plasma turbulence

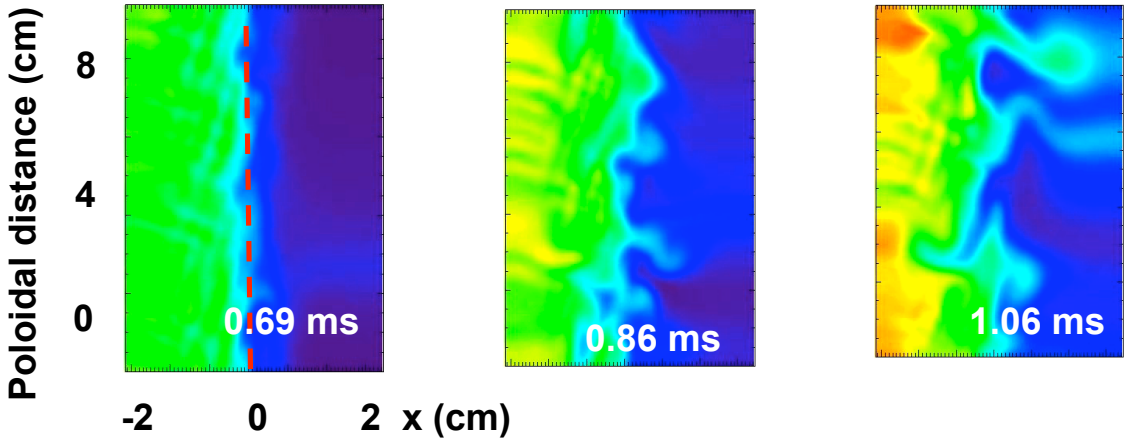
- **Reduced Braginskii equations for N_i, T_e, T_i, $V_{||e}$, $V_{||i}$, and ϕ**
- **Real geometry with X-point**
- **Parallel implementation**
- **Has demonstrated encouraging similarity to some exptl. data**



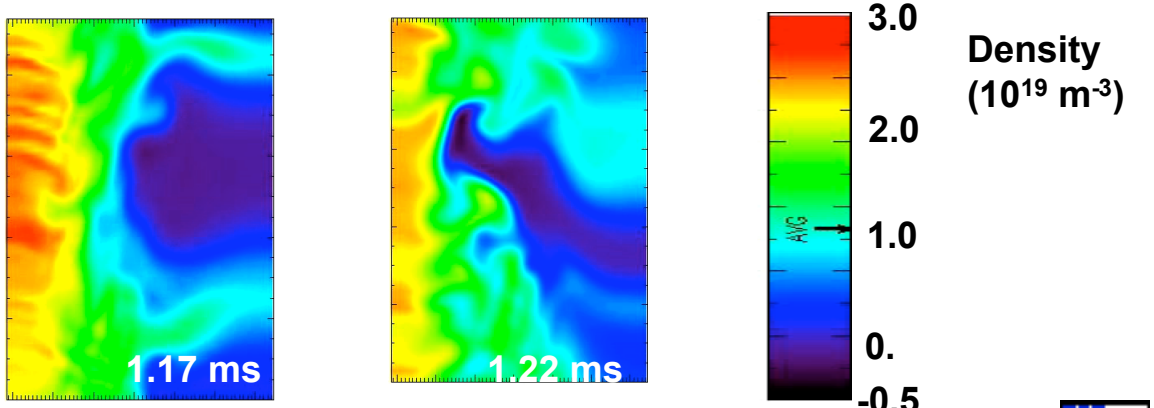
** Originally developed at LLNL by Dr. X.Q.Xu*

BOUT simulation shows convection of plasma "blobs" to the outer wall



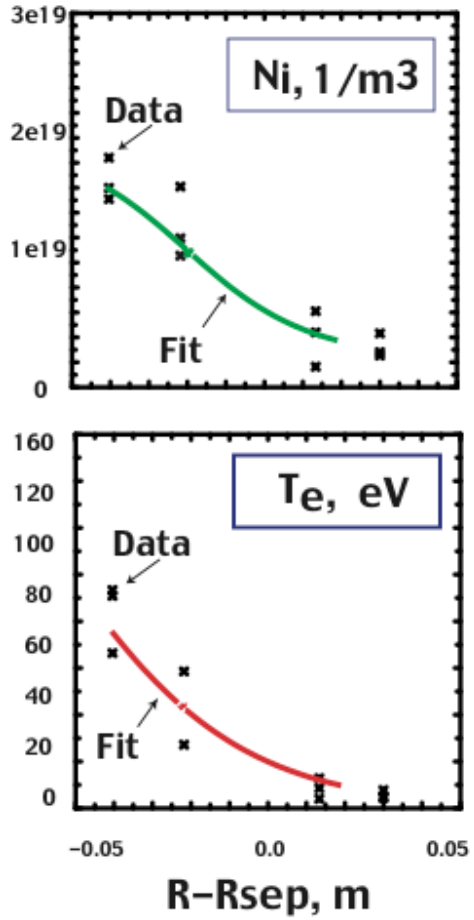


- Analytic neutral model provides source for density build=up over ~1 ms
- Rapid convective transport to wall at higher densities



We have set up a BOUT case for NSTX (work in progress)

- **EFIT-based geometry for NSTX shot 109033 (pre-lithium)**
- **Plasma profiles are fit to radial profiles of T_e, N_i from Thomson data**

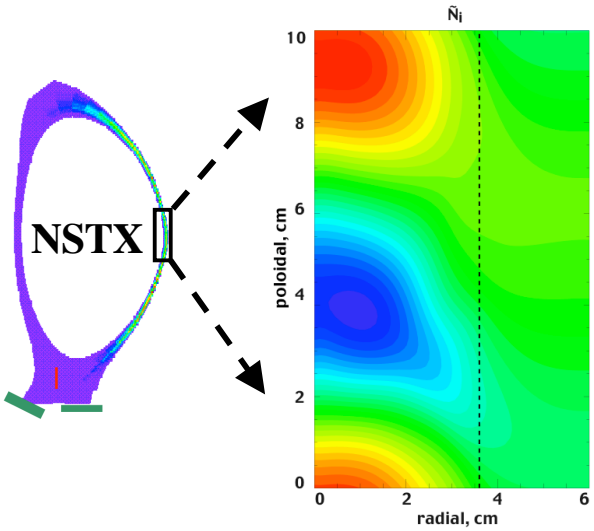


BOUT fluctuations from NSTX case appear to have reasonable spatial and temporal scales

Results of simulations:

- δN_i ~10%
- δT_{ei} ~ 3 eV
- $\delta\phi$ ~10 V
- $L_\perp$ ~ 2 cm
- f ~ 10^5 s^{-1}

BOUT δN_i



Gas-puff imaging data (S.Zweben)

Summary

- **We are developing capability of simulating turbulent edge-plasma fluxes**

- **We have preliminary results of BOUT simulations of NSTX (pre-lithium)**